

Improving of Junior High School Visual Thinking Representation Ability in Mathematical Problem Solving by CTL

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Abstract

The students' difficulty which was found is in the problem of understanding, drawing diagrams, reading the charts correctly, conceptual formal mathematical understanding, and mathematical problem solving. The appropriate problem representation is the basic way in order to understand the problem itself and make a plan to solve it. This research was the experimental classroom design with a pretest-posttest control in order to increase the representation of visual thinking ability on mathematical problem solving approach with contextual learning. The research instrument was a test, observation and interviews. Contextual approach increases of mathematical representations ability increases in students with high initial category, medium, and low compared to conventional approaches.

Keywords: Visual Thinking Representation, Mathematical Problem Solving, Contextual Teaching Learning Approach

Abstrak

Kesulitan yang diperoleh siswa adalah pada saat memahami, menggambar diagram, membaca grafik dengan benar, pemahaman konsep matematika formal, dan penyelesaian masalah matematika. Penyajian masalah yang tepat adalah hal mendasar dalam memahami masalah tersebut dan membuat rencana untuk menyelesaikannya. Penelitian ini adalah desain kelas eksperimen dengan control pretest-posttest dalam rangka meningkatkan penyajian kemampuan berpikir visual dengan pendekatan pemecahan masalah matematika dengan pembelajaran kontekstual. Instrumen penelitian yang digunakan adalah tes, observasi dan wawancara. Pendekatan kontekstual meningkatkan kemampuan representasi matematika siswa dengan kategori tinggi, menengah, dan rendah dibandingkan dengan pendekatan konvensional.

Keywords: Penyajian Berpikir Visual, Penyelesaian Masalah Matematika, Pendekatan Pembelajaran Kontekstual

Introduction

Visualization has an important role in thinking development, mathematical comprehension, and the transition thinking of concrete to abstract thinking related to mathematical problem solving (Lavy, 2006). Visual thinking is interesting to be discussed since many previous studies found that to the use of improper visual representation of students have limitations and difficulties. The students' difficulty

which was found is in the problem of understanding, drawing diagrams, reading the charts correctly, conceptual formal mathematical understanding, and mathematical problem solving (Eisenberg, 1994; Arcavi, 2003; Stylianou & Silver, 2004).

The visualization which is used in mathematics learning can be a powerful tool to explore mathematical problems and to give meaning to mathematical concepts and their relationship (Roska & Rolka, 2006). Many researches have highlighted the benefits of visualization related to mathematical problem solving (Presmeg, 1986a; Presmeg 1986b; Kent 2000; Mariotti, 2000; Slovin, 2000; Thornton, 2001; Yin, 2011).

The increasing of visual thinking representation is very important in order to mathematical problem solving. Modelminds (2012) says there are 10 reasons why visual thinking is important in solving complex problems, they are: (1) Visual thinking helps to understand the complex issues easier, (2) The visualization of complex problems, it becomes easier to communicate and to others to finish, (3) Visual thinking helps people communicate across cultures and languages, (4) Visual thinking makes communication from the emotional side of getting better, (5) Visualization helps facilitate the resolution of non-linear problems, (6) Visualization of the problem enables people to thinking along with each others' ideas by creating a common language, (7) visual mapping of the problem may help to look at the gap of the solution can be found; (8) Visualization helps people to memorize, make ideas concrete and thus creates a more accurate result in the end; (9) Visual thinking can give you the necessary overview to learn from your mistakes; (10) Visualization serves as a great motivation to achieve a goal.

Low-ability students' mathematical problem solving is also caused by the process of mathematics learning in the classroom less improve higher-order thinking skills and less directly related to real life everyday (Sadiq, 2007; Sumarmo, 2010). Learning like this is not in line with the purpose of mathematics in junior high school students, namely that students have problem-solving abilities, and also in line with the principle of the development of Curriculum, which is centered on the potential, progress, needs and interests of learners and the environment are relevant to the needs of life. Whereas the ability of solving math problems is the heart and core of the visualization is on solving math problems.

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According Hudoyo (2002) the weakness of students is on problem solving skills, reasoning, mathematical connections and communications caused by the learning activities are common in the field is not currently accommodate development capabilities it.

The implementation of math learning which is done by the teachers in the schools is related to the findings Curriculum Centre (Puskur). Puskur (2007a) found that the implementation aspects of mathematics teaching in SMP / MTs and SMA / MA are :

(a) Learning does not appropriate with the RPP has been made so it is not focused on the process, just lining the handbook, (b) the less variety of learning method in the classroom, teachers tend to use the speak a lot method, (c) learning method is out of the material (the difficulty in selecting method based on the material given), (d) the use of learning resources and handbooks generally very limited in technology and the environment tools, (e) the assessment given sometimes does not cover all the indicators (basic competencies) which is composing without any grating activity. It needs to be concern.

Sabandar (2005) said that an enhancement in the ability of mathematical representations, teachers through the process of discovery by using the concept of horizontal and vertical mathematization. The concept of horizontal mahtematization form of identification, visualization problems through sketches or drawings that have been known to students. The vertical mathematization concept is the representation of the relation of the form, reconcepting and adjustment of a mathematical model, the use of different models and generalization.

NTCM (2000) has defined five content standards in mathematics, the numbers and operations, problem solving, geometry, measurement, chance and data analysis. In geometry there are several implementation visualization elements, spatial thinking and modeling. It shows that the increasing visual thinking abilities (visualization) are a curriculum requirement that must be accommodated in the learning of mathematics. Based on the national curriculum in Indonesia, namely (KTSP), from primary to college students are required to master the surface geometry material and space geometry and problem solving also requires visualization.

Some forms of mathematical representation, which is students' visual thinking representation such as verbal, drawings, models, numerical, algebraic symbols, tables, charts, and graphs are an inseparable part of a math lesson. However, generally in

learning process, representation is a supplement in solving mathematical problems only. Supposedly as an essential component of learning, the ability of the students mathematical visual thinking representation need to be constantly trained in the process of mathematics learning in school. Montague (2007) confirms the appropriate representation of the problem is the main way to understand the problem and make a plan to solve the problem.

Mathematics learning objectives include developing capabilities: (1) mathematical communication, (2) mathematical reasoning, (3) mathematical problem solving, (4) mathematical connections, and (5) mathematical representation (NCTM, 2000: 7). Sumarmo (2005) confirm the mathematical power ability or mathematical skills (doing math). Sumarmo further stated that through mathematical skills (doing math) above, it is expected to fulfill the students' need nowadays and for future needs of the learners. The need nowadays is the students understand the main concepts to solve math and science problem when they are still in high school level, while the future needs of the students is the students have an excellent math thinking skills in the society in order to compete in international level. Thus, mathematics instruction is expected to develop the mathematical skills of students at any school level through mathematical tasks that support the objectives.

According to McCoy, Baker and Little (Hutagaol, 2007) is the best way to help students in math understand through representation is encouraging them to find or make a representation as a thinking tool in communicating mathematical ideas. Ruseffendi (2005) suggested that one of the important roles in learning mathematics is understanding the direct object of abstract mathematics such as facts, concepts, principles and skills. To achieve it, the concrete objects presentation to help in understanding the abstract mathematical ideas. Thus, in learning process required a good representation skill. The aim of concrete objects is a tool of understanding, and if studied the idea has been conceived, the concrete object is not needed anymore in learning mathematics.

The teachers' are concern in the problem or question in class which is done by by teachers and students is become routine activity and must activity to do in the learning process to emphasis students more active to get involved in the process of knowledge delivery. The questions given are expected to support the achievement learning objectives. It is needed to deliver challenge questions or a kind of divergent questions

or conflicting cognitive in a condition to expect the students to visualize thinking and critical thinking, creative in mathematical problem solving. In order to understand the unstructured mathematical problem, it was used a model of representation in the form of pictures, graphs, tables, and so on. The students reflect on each end of the troubleshooting process, and at the end of each lesson.

Contextual Learning Approach

There are several theories reference contextual learning mathematics. Basically the contextual learning of mathematics refers to constructivism. Slavin (1997: 269) states that learning is the students themselves according konstruktivism must actively find and transfer or build knowledge that will be hers. Students in the learning process to check and adjust the new knowledge learned with the knowledge or frame of mind they already have. The role of teachers in teaching is more as a mediator and facilitator.

Suparno (2001: 10-11), states in essence the teacher acts as a facilitator who is responsible for providing learning experiences that enable students to take responsibility in the learning activities. Teacher or provide activities that stimulate student curiosity in helping students to express their ideas and communicate scientific ideas; provide a means of stimulating students to think productively, encouraging students to monitor, evaluate and demonstrate student thinking that are relevant or irrelevant with which to face the new problem related to students are learning.

Vygotsky (in Slavin, 1997) states that students should learn through interaction with adults or with more capable peers. In this way the students gained an understanding of the higher than he already has. Interactions can be accommodated by learning with peers (groups).

Mathematics learning is contextual also refers to the theory of meaningful learning belonging to the flow of cognitive learning psychology. Ausubel (in Dahar, 1989) states that learning can be categorized in two dimensions related to how knowledge (information, subject matter) is presented to students by linking knowledge to students' cognitive structures that already exist or the student. According to Ausubel meaningful learning is a process of linking new knowledge relevant to the knowledge that was contained in the student's cognitive structure.

Suryanto (2001: 2) states that according to Freudenthal mathematics learning should be linked to the reality of life, close to nature and relevant to the student's mind with the community in order to have human value

On the application of contextual learning, which is a constructivist-based learning gives students the opportunity to explore thoughts, but directionally, discover new ideas solving mathematical problems. Students can also share ideas on the group or ask other groups about issues that are not understand. If there is between students or groups of different opinions, and meet teachers deadlock could help with schaffolding. An active learning environment with these characteristics it is possible to direct the students to be able to perform mathematics learning, which in turn students will have independent study mathematics.

Students with contextual learning approach are expected to have higher math skills than students who received conventional learning. Students who are at high students prior knowledge and high school categories are better able to manage time, diagnosing learning needs and control learning, cognition, motivation and behavior. Also students are able to plan learning strategies, selecting learning strategies, and then implement, and evaluate the process and outcomes of learning. This is supported by findings Darr and Fisher (2004) reported that students' ability to learn independently correlated high with the success of student learning.

This study focused on the application of contextual learning model in an effort to improve the ability of visual representation junior high students thinking in terms of categories of early math skills of students (high, medium and low).

Questioning - Treating Students' Questions

1. Is there an enhancement of students' visual thinking representation (RVT) on mathematical problem solving of who received contextual learning approach (CTL) in terms of: (a) learning approach, and (b) basic math skills (high, medium, low).
2. Is enhancement students' ability RVT in mathematical problem solving with CTL higher than the conventional learning (KV) based on the aspe of aspects: a) learning approach, and (b) basic math skills (high, medium, low).

Method

This research is a quasi experimental contextual approach. The design of this experimental research is using 2 x 3 factorial analysis, the two contextual learning approach (CTL) and the conventional learning (KV), and three groups of students' basic mathematical knowledge (high, medium, and low).

In this design, subjects were selected by choosing two groups of classes in each school, the experimental group was treated for contextual learning (X), and a control group with normal learning (conventional). Before it is started, the experiment class and control class given pretest representation capabilities visual thinking (RVT). Then, at the end of a series of experimental class and control class term were given posttest. This research includes the design of the pretest-posttest control group.

The research sample of students at two junior high schools in Medan and consists of four classes, the second class and second-class control experiment. The sample totaled 169 students, consisting of 32 students of high students prior knowledge (SPK), students prior knowledge 104 students and 33 secondary students from low students prior knowledge.

Instrumentation

The research instrument used in this study used a test to measure the ability of the visual representation of student thinking, observation sheets and interview guides. Visual representation of the thinking ability test used to measure the ability of the visual representation of mathematical thinking before and after the learning of mathematics with a contextual approach. Before the first test used the validated tests to determine content validity, face validity and construct validity. Content validation, face validation carried out by providing learning tools to the experts for their views. Construct validity tested to 30 junior high students in Medan.

Indicators are measured on a visual representation of thinking ability of students covering aspects: (1) Ability to present problems in the form of visual (diagrams, drawings, tables, and patterns), (2) capable of presenting problems in the form of mathematical equations (a mathematical expression) or the mathematical model; (3) be able to retell the problem or problems in a systematic way or the conclusion of the answer, (4) Ability to plan, implement strategies to solve the problem, (5) Being able

to check the answer to the problem solution, (6) Ability to describe the problems and solutions instead of calculating.

Results and Discussion

RVT Ability Students Based Learning Approach Students' Prior Knowledge in Table 1. The results of the descriptive analysis of the data based on SPK and RVT student learning approaches. Students who come from a group of high SPK, RVT their abilities increase from 24.93 to 45.86, after getting CTL. Students who obtain KV ability students increased from 21.44 to 31.22. An increase is respectively by 0.69 and 0.28.

Table 1
Description RVT Students Ability Based on Basic Mathematics Capabilities and Learning Approach

SPK Group	Description RVT	Learning Approach					
		P-CTL			P-KV		
		Pretest	Postes	N-Gain	Pretest	Postes	N-Gain
High	n	14	14	14	16	16	16
	average	24,93	45,86	0,69	21,44	31,22	0,28
	standard deviation	6,43	6,13	0,15	5,63	4,92	0,10
Medium	n	52	52	52	52	52	52
	average	18,37	36,42	0,51	16,62	25,23	0,22
	standard deviation	6,92	9,29	0,20	3,63	5,11	0,10
Low	n	16	16	16	17	17	17
	average	12,0	26,31	0,32	116,94	23,94	0,19
	standard deviation	2,48	3,52	0,08	6,24	7,64	0,11

Students who come from the middle SPK after obtaining contextual learning, RVT increased from 18.37 to 36.43 while students who received conventional learning. RVT occurs improved them from 16.62 to 25.23. Means there is an increase amounting to 0.505 and 0.219. The data also showed an increase in the ability of RVT larger middle group that gets SPK contextual learning compared to students in the group increased RVT high gain conventional learning.

Students who come from low SPK group after getting P-CTL, RVT students increased from 12.0 to 26.31. Students who find learning conventional learning, RVT students increased from 16.94 to 23.94, an increase of respectively 0.324 and 0.185. To see the

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significance of the increase RVT ability students, the results of the descriptive analysis examined statistically significantly increased.

Table 2. Improved Real Test RVT Each SPK Group

Description	Students' Prior Knowledge Group					
	High		Medium		Low	
	P-CTL	P-KV	P-CTL	P-KV	P-CTL	P-KV
n	14	18	52	52	16	17
average	0,688	0,281	0,505	0,219	0,324	0,185
t	17,29	11,50	18,17	15,22	15,98	6,94
db	13	17	51	51	15	16
Sig.	0,00	0,00	0,00	0,00	0,00	0,00
Decision	Reject H ₀	Reject H ₀	Reject H ₀	Reject H ₀	Reject H ₀	Reject H ₀

In Table 2. Students' RVT ability was improved in the medium level of students' prior knowledge (SPK) significantly among the three SPK level groups who received contextual learning. Therefore, there was a significant improvement of the students' ability in the high level SPK that got conventional learning RVT, contrary for the medium and low level. Descriptively the average increasing of students' RVT who received contextual learning is higher than the increasing of students' RVT who obtain conventional learning (KV), and the difference was also statistically significant.

The interaction of learning approach and SPK in improving students' learning ability was conducted in order to test t the hypotheses that have been stated that "there is interaction between teaching approaches (P-CTL, P-KV) and students' SPK group (high, medium, low) in improving students' learning ability". Instead to testing hypothesis done first tested the homogeneity of variance using Levene's test. The results of the probability value (sig) = 0.000 is less than 0.05 so the decision was received Ho. Means variants KB student improvement data on the interaction between teaching approaches and the SPK is not homogeneous.

The results of interviews with students in the class of high SPK group experiment show that the student enjoys learning math with contextual learning approach. Students expressed are enjoying an atmosphere of learning and teachers' ways or strategies to manage the learning process that is different from usual. Students are happy if they have trouble giving teachers enter, ideas and questions to help students

solve problems without telling straight answer. Students also stated that they are becoming bolder and more confident present their answers to the class after the previous answers are agreed upon in the group. However, some students expressed dislike and can not draw such issue or object.

Students at the middle and lower SPK experimental class also expressed the same opinion. They are enjoying the process of learning that teachers do. Contextual Learning math is done occasionally find mathematical expressions, solve the problem with the model drawings, sketches, graphs, and relate it to real life everyday. They expressed more easily understood and more independent in solving mathematical problems after first describe or sketch as a given problem.

The findings and interview the students who have problems with the representation of the image shows the process and results of mathematical settlement construction will also experience problems or difficulties.

Sketch of answers students who have problems with the representation does not look like a swimming pool that is similar to a cut-up beam. The image created looks like shit. When asked why the picture the reply came "can not draw" and "confused drawing pool" pool situation in the given problem. What is considered but the paperwork students can not describe the situation (model problem) is actually in mathematical problem solving is also seen not able to finish. Mathematical representation has been declared as one of standard process that must be achieved by students through the learning of mathematics, but in practice is not something that is easy and simple. Limited teacher knowledge and learning habits of students in a conventional manner and yet independent in the classroom has not been possible to grow or develop resources in an optimal representation of students

The results of the student's work is found in the visual representation of student thinking in the form of sketches / drawings on solving mathematical problems found include: (1) students are not drawing (symbols, diagrams) as appropriate, (2) the image is too small and not true, (3) messy picture without explanation. This is consistent with the findings Diezmann (2000) who found (1) in which the diagram is too small to represent all the relevant information on the issue, (2) where the diagram too cluttered for troubleshooting to see elements of the problem more clearly. A result of inaccurate representations resulted in the further process of students experiencing difficulties. The work of students in problem solving in line with the findings of

Mayer (1992) which states representation results have been seen as an important stage of the process of solving a problem, especially in the early stages (Lowrie & Hill, 1996).

Drawing sketch is not appropriate with the real issue that is going to difficult for the students in processing solving a problem or proofs. This is in line also with the Gibson (1998) found that students use the diagram is a form of visualization in order to understand and construct proofs. Stylianou (2000) states about the two different forms of thinking in cognitive studies on the use of visualization in the problem solving process: (1) thinking in the visual representation is given as part of the problem and support the process of thinking, (2) thinking in the visual representations which is built by solving problem solving and used as a tool in the process of problem solving.

The results of the interview was found the difficulties of the students in representing visual thinking in mathematical problem solving, they are: (1) the students were confused in describing, (2) were not pleasure (hate) to draw, (3) what he thinks and wants to represent was inappropriate, (4) have no idea to get started representation, (5) lack of confidence at the time of launch, the processing time and after pictures completed. This is related to the research of Panasuk and Beynarevand (2010) found that students sometimes do not like it or hate it with a drawing in mathematical problem solving. Students with less confidence cause the unexpected result of what they do. Eisenberg (1994) also states that most students do not like to think of using the images, and do not like those documented in the literature. Instead students are accurating presented the picture will be more independent, motivated and more confident in mathematical problem solving. This is in line with the findings of Zimmerman (1989) found that the independent students are the one who have self-confidence and high intrinsic motivation. So does Pintrich, et al (1999) suggest the important to emphasis of motivational and cognitive components for the students to learn independently.

Conclusion

Based on the analysis and discussion in this study, we can conclude that P-CTL can improve RVT ability students' prior knowledge in all three groups' level (high, medium, and low). Students' RVT ability in all three groups is significantly

increasing the SPK. In the high, medium, and low SPK differences are improving in students' getting RVT ability who got P-CTL treatment contrasting the students who were treated by conventional learning are statistically significantly different.

The increasing of students RVT ability in middle and low SPK who treated by P-CTL is higher than the students who treated by conventional learning. There is interaction between teaching approaches and basic math skills of the students (high, medium, and low) to increase student RVT ability.

References

- Arcavi, A. (2003). The Role of Visual Representations in the Learning of Mathematics. *Journal of Mathematical Education in Science and Technology*, 29 (3), pp. 401-420.
- Darr, C., & Fisher, J. (2004). *Self-Regulated Learning in Mathematics Class*. (online) available: www.arb.nzcer.org.n-z
- Diezmann, C. M. (2000). The Difficulties Students Experience in Generating Diagrams for Novel Problems. In T. Nakahara & M. Koyama (Eds), *Proceedings of the 24th Conference of The International Group for The Psychology of Mathematics Education* (Vol. 2 pp. 241-248). Hiroshima, Japan: PME.
- Eisenberg, T. (1994). On The Understanding The Reluctance to Visualize in Mathematics. *Zentralblatt fur Didaktik der Mathematik*, 26, 109-113.
- Gibson, D. (1998). *Students' Use of Diagrams to Develop Proofs in an Introductory Analysis Course*. A. H. Schoenfeld, J. Kaput, ve E. Dubinsky (eds), *CBMS Issues in Mathematics Education III*, 284-307.
- Hudojo, H. (2002). Representasi Belajar Berbasis Masalah. *Jurnal Matematika dan Pembelajarannya*. ISSN : 085-7792. Tahun VII.
- Hutagaol, K. (2007). *Pembelajaran Matematika Kontekstual untuk Meningkatkan Kemampuan Representasi Matematis Siswa Sekolah Menengah Pertama*. Bandung. Tesis pada SPS UPI. .
- Lavy, I. (2006). Dynamic Visualization and The Case of 'Stars in Cages'. *Proceedings 30th Conference of The International Group for the Psychology of Mathematics Education*, Vol. 4, pp. 25-32. Prague : PME.
- Lowrie, T. & Hill, D. (1996). The Development of a Dynamic Problem-Solving Model. *Journal of Science and Mathematics Education in Southeast Asia*, XXIX(1). 1-11
- Mariotti, M.A. (2000). Introduction to Proof: The Mediation of a Dynamic Software Environment. *Journal Educational Studies in Mathematics*, 44 (1-2) 25-53
- Mayer, R.E. (1992). *Thinking, Problem Solving, Cognition* (2nd ed.). New York: W.H. Freeman.

- Modelminds. (2012). *10 Reasons Why Visual Thinking is Key to Complex Problem Solving*. May, 9, 2012 – 15:46. Tersedia di blog.modelmind.nl?p=5850
- Montague, M. (2007). *Math Problem Solving for Middle School Students with Disabilities*. Available: <http://www.k8accesscenter.org/trainingresources/MathProblemSolving.asp>.
- NCTM. (2000). *Principles and Standards for School Mathematics*. Reston VA: NCTM.
- Panasuk, R. & Beyranevand, M. (2010). Algebra Students' Ability to Recognize Multiple Representations and Achievement. *International Journal for Mathematics Teaching and Learning*. Available di <http://www.cimt.plymouth.ac.uk/journal/panasuk.pdf>
- Pintrich, P. R., Smith, D. A., Gracia, T., and McKeachie, W. J. (1999). *A Manual for the Use of the Motivational Strategies for Learning Questionnaire (MSLQ)*. University of Michigan: National Centre for Research to Improve Postsecondary Teaching and Learning.
- Presmeg, N. (1986a). Visualization in High-School Mathematics for the Learning of Mathematics. *Journal Educational Studies of Mathematics*, 6(3),42-46
- _____. (1986b). Visualization and mathematical giftedness. *Journal Educational Studies in Mathematics*, 17 (3), 297-311
- Puskur. (2007a). *Kajian Kebijakan Kurikulum Mata Pelajaran Matematika*. Jakarta: Depdiknas Badan Penelitian dan Pengembangan Pusat Kurikulum
- Rosken, B., & Rolka, K. (2006). A Picture is Worth A 1000 Words. The Role of Visualization in Mathematics Learning. *Proceeding 30th Conference of The International Group for The Psychology of Mathematics Education*. Vol. 4. pp. 457-464. Progue: PME.
- Sabandar, J. (2005). *Pertanyaan Tantangan dan Memunculkan Berpikir Kritis dan Kreatif dalam Pembelajaran Matematika*. Makalah Disajikan pada *Seminar MIPA di JICA*: tidak diterbitkan.
- Shadiq, F. (2007). *Laporan Hasil Seminar dan Lokakarya Pembelajaran Matematika dengan Tema “ Inovasi Pembelajaran Matematika dalam Rangka Menyongsong Sertifikasi Guru dan Persaingan Global”*, yang dilaksanakan pada tanggal 15 – 16 Maret 2007 di P4TK (PPP) Matematika Yogyakarta.
- Slavin, Robert R. (1997). *Educational Psychology-Theory and Practice*: Fifth Edition. Massachussetts: Allyn and Bacon.
- Slovin, H. (2000). *Moving to Proportional Reasoning*. *Mathematics Teaching in the MiddleSchool*. 6 (1) 58-60
- Sumarmo, U. (2005). *Pengembangan Berpikir Matematik Tingkat Tinggi Siswa SLTP dan SMU serta Mahasiswa Strata Satu (SI) melalui Berbagai Pendekatan Pembelajaran*. Laporan Penelitian Hibah Pascasarjana Tahun Ketiga : Tidak diterbitkan.

- _____. (2010). *Berfikir Disposisi Matematik: Apa, Mengapa, dan Bagaimana Dikembangkan pada Peserta Didik*. FPMIPA UPI. Tersedia di ac35.4shared.com/doc/ourBAi09/preview.html.
- Suparno, P. (2001). Konstruktivisme dalam Pendidikan Matematika. Makalah tidak dipublikasikan pada *Lokakarya Widyaiswara BPG se-Indonesia*, tanggal 27 Maret s/d 9 April 2001 di PPPG Matematika Yogyakarta.
- Suryanto. (2001). Pendidikan Matematika Realistik. Makalah tidak dipublikasikan pada *Lokakarya Widyaiswara BPG se-Indonesia*, tanggal 27 Maret s/d 9 April 2001 di PPPG Matematika Yogyakarta.
- Stylianou, D. A. (2000). *Expert and Novice Use of Visual Representations in Advanced Mathematical Problem Solving*. Unpublished Doctoral Dissertation. University of Pittsburgh.
- Stylianou, D.A., & Silver, E.A. (2004). The Role of Visual Representations in Advanced Mathematical Problem Solving: An Examination of Expert-Novice Similarities and Differences. *Journal of Mathematical Thinking and Learning*, 6(4), 353-387.
- Thornton, S. (2001). *A Picture is Worth a Thousand Words. Why Visual Thinking*. Online : Math.unipa.it/~grim/Athornton251.pdf
- Yin, H. S. (2011). *Seeing The Value of Visualization*. Available: <http://www.singteach.nie.edu.sg/...-/190-seeing-the-value-of-visualization.html> -Cached
- Zimmerman, B. J., & Schunk, D. H. (1989). *Self-regulated Learning and Academic Achievement: Theory, Research, and Practice*. New York : Springer-Verlag.

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